INL project manager Kelly Lively led the INL effort to painstakingly assemble and extensively test the radioisotope power system for the Mars Science Laboratory mission's Curiosity rover.

Mars Science Laboratory team accomplishes mission goal by working together

By Teri Ehresman, *INL Communications and Governmental Affairs*

Teamwork. That sums up years of efforts by Idaho National Laboratory employees who kept their eye on the goal of providing the power source for the Curiosity rover when it launched in the Mars Science Laboratory rocket to Mars in late November.

Many of the team members spent the last five plus years focusing on assembling and testing the Radioisotope Power System (RPS) for the mission. The Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) will provide a continuous source of heat and power for the rover's instruments.

Many members of the INL radioisotope power system team watched the Mars Science Laboratory launch on Nov. 26, 2011.

The power system provides about 110 watts of electricity and can run continuously for many years. The nuclear fuel is protected by multiple layers of safety features that have undergone rigorous testing under varied accident scenarios.

Before the launch, the device was painstakingly assembled and extensively tested by the INL team before heading to space.

Kelly Lively, MMRTG project manager, led the team effort. She joined the RPS family in 2004 as a subject matter expert for the New Horizons launch and her responsibilities grew after that launch in 2006. Her boss, Director of INL's Space Nuclear Systems and Technology Division Stephen Johnson, said her leadership was key to the success of the program.

The team began assembling the power source in the summer of 2008. Late that year, the power system was fully fueled, assembled and ready for the intense testing to make sure it would withstand the expected conditions in space and on Mars. The testing was completed in May 2009, but by then, the planned September 2009 launch had been delayed 26 months because of hurdles with other parts of the mission. So, the INL team kept the power system stored in Idaho until this past summer when it was shipped to Kennedy Space Center in preparation for the launch.

Some INL team members pose in NASA's Vertical Integration Facility, where they assisted the installation of the power system.

During the delay, the team reviewed procedures, kept current on training and worked with the Jet Propulsion Laboratory and NASA to make sure everything was ready for the 2011 launch.

When the power source was delivered to Florida, a team of about 20 was on hand to make sure the power generator was stored safely and maintained in a ready condition for the launch. The team spent most of July working on areas such as safety, quality assurance and finalizing procedures to prepare for the launch. This was also the first time the MMRTG was connected to the rover and INL team members spent much of their time ensuring installed instrumentation had the necessary power to function. They also performed mechanical and electrical inspections to make sure the battery seamlessly integrated with the rover. "It was a great work environment; everyone worked together to make sure we worked safely and got the job done," Lively explained.

When that task was completed, three teams of two experts each rotated duty in Florida to monitor the power source and be on hand for planning meetings and other launch-related activities.

"Our team spent a lot of time on travel preparing for this part of the mission," Lively explained. "While it sounds like a lot of fun, it also was a lot of work, and at a sacrifice to employees' family members back at home to do what was right for the MMRTG program."

Launch day approaches

About 10 days before the scheduled launch, a team of around 20 assembled in Florida for the final

launch preparations. Nearly a week before the launch, the team was divided into two teams working 12-hour shifts to move and integrate the RTG onto the Mars Science Laboratory rocket. The team participated in a practice run a couple of days before the actual transfer was to take place. "We wanted to make sure our procedures were correct and we were ready for the actual move," Lively said.

The multi-mission radioisotope thermoelectric generator (MMRTG), left, was encapsulated within the payload fairing of the Atlas rocket.

The first shift team began work very early in the morning with a safety briefing by Eric Clarke, lead engineer for ground operations at Kennedy Space Center. He told the group this was something they had practiced many times before and "now this time it is for real." The team then began the task of moving the storage compartment holding the RPS to a large semi-truck and transporting it to the Vertical Integration Facility (VIF). At daylight, the power system was lifted by a huge crane into the VIF, where the next shift started the process of attaching it to the rover with four large bolts and connecting electrical and other equipment. Within 48 hours, the power source had been attached to the rover and was ready for the launch.

INL technicians in NASA's Vertical Integration Facility prepare to install the multi-mission radioisotope thermoelectric generator (MMRTG) on the Curiosity rover.

"This was a great team effort. We kept to the outlined schedule and successfully integrated the RPS to the rover atop the rocket," Lively said. "The team is very passionate about the health of the power system. We work very hard in training and are very meticulous in regard to performing activities on or near the RPS. It is important to perform activities correctly the first time so as not to damage the system – it's a one-of-a kind space battery."

Following the integration of the RTG to the rover, part of the 20-person team was able to head back to Idaho, its task complete. A group of 14 stayed in Florida through the launch in case it was delayed beyond the nearly three-week window and the power source had to be removed from the rocket and stored.

After the successful launch on Nov. 26, the team spent two days collecting equipment and loading it into two semitrucks that are headed back to INL for the next launch.

Johnson called the launch a very happy day for him as well. "After eight plus years of working on this effort, we saw a perfect launch and completion of the project," he said.

Team member Jamie Mitchell called the project "more fun than most projects." He said he was happy that the launch occurred without major issues.

Lively says she is now anxiously waiting for the day when MSL lands on Mars in early August. She plans to celebrate the Mars landing as another important milestone for the project.

The Atlas V rocket before its launch to carry the Mars Science Laboratory mission's Curiosity rover to the red planet.

Looking to the future, NASA is considering a nuclear power system for two of the three options under consideration for a Stirling engine for a future deep space mission, possibly as early as 2016.

With the experience gained on the New Horizons mission and now the Mars Science Laboratory, the team at INL is poised and prepared to continue delivering a highly sophisticated battery system that helps increase the world's knowledge about the existence of life in the universe.

Minutes after the team cheered the completion of this project and the successful launch of MSL, many were ready to look forward to the next adventure. Several team members said they are ready and waiting for the next space power mission — and the challenges and teamwork that come with it.

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